

REMARKS

Reconsideration and allowance of this application are respectfully requested in light of the foregoing amendments and the following remarks.

Claim Status

Claims 1-14 are pending in the application. Claims 15-19 are withdrawn from consideration. Claims 1, 6, 13, and 15 are amended. New claims 20-25 are added. Support for the new claims is found in the amended claims. No new matter is added.

Restriction Requirement

The Examiner has indicated that when the proton conducting polymer membrane of Group I is in condition for allowance, then the remaining claims will be rejoined and allowed.

Please note that withdrawn claim 15 has been amended and new claim 25 added. Thus, new claim 25 is now withdrawn.

§112 Rejection

Claims 1 and 13 (and presumably claims 6 and 15) are rejected as being indefinite. These claims have been amended to correct the informality and new claims 20-25 added. Accordingly, this rejection must be removed.

Claim 1 (and presumably claim 15) are rejected as being indefinite for the use of "obtainable." "Obtainable" is changed to --made--. Accordingly, this rejection must be removed.

\$103 Rejection

Claims 1-14 are rejected as unpatentable over Madison (US5218076) or Savinell (US5525436). Applicant respectfully disagrees.

The claims distinguish Savinell. The claims recite that the monomers for the recurring benzimidazole units are mixed "in a polyphosphoric acid/sulfonating agent mixture." Whereas, Savinell teaches that one dopes the PBI with "a strong acid, such as phosphoric acid or sulfuric acid" [emphasis added], Savinell, column 1, lines 56-58, column 6, lines 36-38, and column 7, lines 52-54. Nowhere does Savinell mention polyphosphoric acids¹ or a combination of an acid and a sulfonating agent. Therefore, Savinell does not suggest the claimed invention and the rejection must be removed.

The claims distinguish Madison. Madison is directed to PBZ polymers used as high performance materials. Those high performance materials exhibit "remarkable high-temperature

¹ Phosphoric acid (AKA orthophosphoric acid) and polyphosphoric acids are different. *Phosphoric acids and phosphates*, Wikipedia, relevant pages attached.

stability, high tensile strength [and] high tensile modulus...[and] are resistant to harsh environments. Madison, column 1, lines 43-50. These polymers are subsequently formed into fibers and films which are used as the reinforcing agents in composite materials. Madison, column 1, lines 51-last line. To further improve these PBZ polymers, Madison looks at ways to form 'branched' PBZ polymers. Madison, Title, column 1, lines 18-20, Summary of Invention ("process for making branched PBZ polymer" - column 2, lines 3-4; "branched polymer" - column 2, line 24; "branching agents useful in making branched PBZ polymer" - column 2, lines 30-31; "dope comprising...branched PBZ polymer" - column 2, line 45; and "article...comprising...branched PBZ polymer" - column 2, last lines). Madison does not mention fuel cells, PEMs, doping, or polymer conductivity.

Applicant contends that the skilled person would not be motivated to consider Madison because it not directed to a "proton-conducting membrane" as set forth in claim 1. Madison is not directed to the field of endeavor of the instant invention, fuel cells (proton-conducting membranes), nor is it directed to the same problem, improving the conductivity of the membrane. Thus, the skilled person would not consider Madison.

The Examiner contends that Madison teaches the "reactants" used in the instant invention. Applicant respectfully disagrees.

Madison, under the section headed "II. Synthesis of Branched PBZ Polymers" says that the reactants are "at least one branching agent" and "at least one PBZ monomer or a chain of PBZ mer units." Madison does not teach that polyphosphoric acid or a sulfonating agent or a combination of both are reactants.

Madison does mention that the reaction is conducted in a "dehydrating solvent." But, this is a reaction media and not a reactant. The dehydrating solvent is not a reactant². Madison defines, at column 4, lines 15-32, the dehydrating solvent as: "Any non-oxidizing liquid solvent capable of placing at least a portion of the branching agents, PBZ monomers and resulting branched PBZ polymer into solution during a PBZ polymerization reaction. The dehydrating solvent must not substantially oxidize reactants dissolved therein which contain o-amino-basic moieties. The dehydrating solvent must also compensate for water formed during the polymerization resulting from an azole ring forming reaction between an electron-deficient carbon group and an o-amino-basic moiety. It is also believed that dehydrating solvents facilitate azole ring formation." [emphasis added] It is clear that the dehydrating solvent does not participate in the reaction as a reactant.

² **Reactant:** Chemistry. any substance that undergoes a chemical change in a given reaction. www.Dictionary.com Unabridged, Based on the *Random House Dictionary*, © Random House, Inc. 2010.

In view of the foregoing, the rejections based upon Madison and Savinell must be removed.

Double Patenting Rejections

Claims 1-14 are rejected on the grounds of nonstatutory obviousness-type double patenting over US7235320, or US7332530, or US734552, or US7540984, or US7582210. Applicant respectfully disagrees.

The invention set forth in the claims is patentably distinct from '320, '530, '552, '984, and '210. In the instant claims, the PBI monomers are mixed with "polyphosphoric acid (PPA)/sulfonating agent mixture" before heating. While in '320, '552, '984, and '210, the PBI monomers are mixed with PPA before heating. In '530, the PBI monomers are mixed with a vinyl-containing sulfonic acid before heating. Moreover, each produces its own unique results. Accordingly, the instant claims are patentably distinct from the listed patents and therefore, the double patenting rejection must be removed.

Conclusion

In view of the foregoing, Applicant respectfully requests an early Notice of Allowance in this application.

Respectfully submitted,



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Phosphoric acids and phosphates

From Wikipedia, the free encyclopedia that anyone can edit

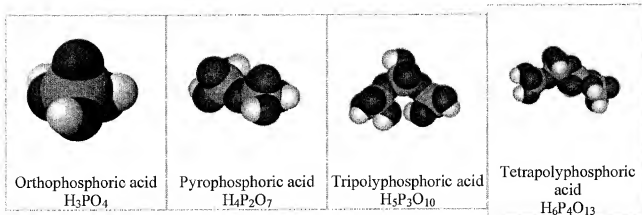
This article compares various kinds of **phosphoric acids and phosphates**.

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Orthophosphoric acid

The simplest compound of a series of **phosphoric acids** is sometimes called by its common name, **orthophosphoric acid**, but more often called by its IUPAC name, simply **phosphoric acid**, by both non-technical people and even many chemists. The chemical formula of orthophosphoric acid is H_3PO_4 and its chemical structure is shown in the illustration below. There is a separate article on this most important compound in the series under Phosphoric Acid. However, two or more orthophosphoric acid molecules can be joined by condensation into larger molecules by elimination of water. This way, a series of **polyphosphoric acids** can be obtained.

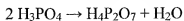


phosphate by both non-technical people and many chemists alike; see a separate article on phosphate for details.

Because orthophosphoric acid can undergo as many as three dissociations or ionizations (losses of H^+ ions), it has three acid dissociation constants called K_{a1} , K_{a2} , and K_{a3} . Another way to provide acid dissociation constant data is to list $\text{p}K_{a1}$, $\text{p}K_{a2}$, and $\text{p}K_{a3}$ instead. Orthophosphate is in a sense the triple conjugate base of phosphoric acid and has three related basicity constants, K_{b1} , K_{b2} , and K_{b3} , which likewise have corresponding $\text{p}K_{b1}$, $\text{p}K_{b2}$, and $\text{p}K_{b3}$ values.

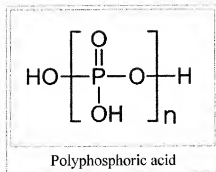
Polyphosphoric acids

When two orthophosphoric acid molecules are condensed into one molecule, **pyrophosphoric acid** ($\text{H}_4\text{P}_2\text{O}_7$) is obtained as follows:



The chemical structure of pyrophosphoric acid is also shown in the illustration. There is also a separate article on Pyrophosphoric acid. Three orthophosphoric acid molecules can condense in a row to obtain **tripolyphosphoric acid** ($\text{H}_3\text{P}_3\text{O}_{10}$), which is also shown in the illustration. This condensation process can continue with additional orthophosphoric acid units to obtain

tetrapolyphosphoric acid ($\text{H}_6\text{P}_4\text{O}_{13}$, pictured) and so on. Note that each extra phosphoric unit adds 1 extra H (hydrogen) atom, 1 extra P (phosphorus) atom, and 3 extra O (oxygen) atoms. The "backbone" chain of these types of molecules consists of alternating P and O atoms covalently bonded together. Polyphosphoric acid molecules can have dozens of such phosphoric units bonded in a row. A general formula for such poly-acid compounds is $\text{HO}(\text{PO}_2\text{OH})_x\text{H}$, where x = number of phosphoric units in the molecule. The four oxygen atoms bonded to each phosphorus atom are in a tetrahedral configuration with the phosphorus in the center of the tetrahedron and the oxygens in each of the four corners.



Polyphosphates

In a pyrophosphoric acid molecule, there are four hydrogens bonded to oxygens, and one, two, three, or all four can be lost as H^+ ions. When all four are lost from pyrophosphoric acid, a **pyrophosphate** ion is formed. Because pyrophosphoric acids can undergo four dissociations, there are four K_a values for it, as well as four corresponding $\text{p}K_a$ values. Similarly, pyrophosphate is a base with four K_b and, of course, four $\text{p}K_b$ values for regaining the H^+ ions in reverse order.

The situation with higher order polyphosphoric acids and polyphosphates continues in a similar way. Tripolyphosphoric acid can lose up to five H^+ ions to form a **tripolyphosphate** ion, tetrapolyphosphoric acid can lose up to six H^+ ions to form **tetrapolyphosphate**, etc. As more dissociations per molecule are possible, the intervals between individual $\text{p}K_a$ and $\text{p}K_b$ values now start becoming smaller on the pH scale.

As the polyphosphoric molecules grow increasingly larger and more complex, practically any number of the somewhat acidic -OH groups in them can dissociate to become negatively charged oxygens, forming numerous combinations of multiple-charged polyphosphoric/polyphosphate anions. Generally in an aqueous solution, the degree or percentage of dissociation depends on the pH of the solution.